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TABLE OF CONTENTS.

Growth of Ant Mounds. <i>E. A. Andrews</i>	75
Notes on the Giant Water Bugs. <i>H. B. Hungerford</i>	88
Insect Food Habit Ratios on Quelpart Island. <i>H. B. Weiss</i>	92
Notes and Descriptions of the Cercopidæ of Cuba. <i>Z. P. Metcalf and S. C. Bruner</i>	95
Pectinate Antennæ in the Geometridæ. <i>Wm. T. M. Forbes</i>	106
Note on Panurgidæ (Bees). <i>Charles Robertson</i>	113
Another Instance of the Northward Migration of Odonata in the Spring. <i>R. H. Howe, Jr.</i>	113
The North American Varieties of <i>Volucella bombylans</i> Linn. <i>Charles W. Johnson</i>	114
International Entomological Congress.....	117
The New York State List of Insects.....	118

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No. 2

GROWTH OF ANT MOUNDS.

BY E. A. ANDREWS.

Johns Hopkins University.

It is well known that many sorts of ants dig into the ground and carrying out mouthfuls of earth soon make conspicuous ant hills above their subterranean dwellings. In some, these mounds are of considerable size and of long duration and serve as nests or places for rearing the young.

The best known mound builder in America is the rather large red and black *Formica exsectoides*, the mound builder of the Alleghanies, whose mounds are seen here and there in Nova Scotia, Ontario, Maine, New Hampshire, Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, Maryland, North Carolina, Georgia, Wisconsin, Illinois, and Colorado. As one of these mounds may contain more than a ton of earth it becomes of interest to find out how long the ants must labor to accumulate so relatively vast masses of material. One of these ants, alive, weighed 10 milligrams.

When the Rev. H. McCook in 1876 studied the "ant city" of local fame near Holidaysburg in Pennsylvania where this ant, which he called the wood or fallow ant (locally called pismires) had built up as many as 1700 mounds, he soon decided, from the occurrence of the very largest mounds on old charcoal hearths, that even the mounds that might contain 300 cu. ft. of earth were not of any very great age. He also recorded that a field plowed in September 1875 showed new mounds in February 1877; one ten inches high and 35 in diameter; a second 14 by 48. As the work of the ants stops in November these mounds were made, he thinks, in a little over one season of work. Again in a corn field in July 1876 were two new mounds, each made in two months, or one third of a working year, and each measured 8 inches in height and 18 in diameter. The first hill was, he

points out, built up at the rate of $1\frac{1}{4}$ cu. ft. per annum, the second at the rate of 3, and the other two at the rate of 1. The second hill arrived in about one year to above the average size of the mounds of that region, and its very great rapidity of growth may have been due, McCook supposes, to the fact that it was not a new colony but was reconstruction work built up on the ruins of an old mound.

McCook inferred that mounds might require five to seven years to be built up to average size and that once full grown they do but hold their own. He says there were good reasons to suppose that some of the large mounds might be thirty years old but no evidence that any of them last through great periods of time. McCook states that the two small mounds in the corn field were probably new communities and it is evident that only such new communities should be considered in reckoning the initial rate of construction. Each mound is the communal work of a family and grows as the family prospers and multiplies year by year since its individuals escape death in the winter by withdrawing deep under ground in subterranean tunnels and are known to be able to live in captivity as much as seven years. The very rapidly rebuilt mounds on the other hand are the reconstruction work of prosperous communities that are able to repair even great amounts of destruction and removal of old mound materials.

As these estimates of McCook on the rate of building mounds by *Formica exsectoides* seem to be the only ones printed, the following data collected near Baltimore, Md., may be worthy of record.

Near Lutherville and Timonium in Baltimore County there is a settlement of these ants embracing some two hundred mounds and measurements made at irregular intervals from 1905-1924 furnish added means for judging of the rate of growth and the age of the mounds of these ants. During this period some of the mounds have remained in existence; either growing or remaining stationary in size; others have disintegrated; and others have sprung up anew. Parts of the entire area have been largely abandoned and other parts have been invaded by new mounds. In one of these newly populated areas measurements have been

made of a certain new mound and incipient community which has grown to maturity along with many others established during this period in the same area, which was a very sterile flat of several acres covered with reddish-iron-ore earth: refuse removed formerly from large adjacent bog-iron-ore pits.

When first seen July 7, 1906, this new nest was conspicuous amidst the sparse grass as being a few handfuls of light yellow and white pellets of irregular size brought up from the subsoil and piled up amidst the grass in an irregular mass three inches high and nine inches wide. There were no holes into the middle of the nest, but large irregular entrances about the base on the N. W. S. and E. sides. It was about 150 feet from an old nest, No. 59 of a survey in 1905, that has remained there since despite the encroaching Japanese honeysuckle and has grown from five, to six by eight feet in diameter, and from 2 to nearly three feet in height, with a circumference of 22 feet. Possibly from this large nest came the female that started the incipient nest. When disturbed the ants in this incipient nest swarmed out and made a rustling sound running over the dead leaves near the nest, but they were but few in number though so rapidly covering all the surroundings.

When next measured, November 13, 1906, this incipient nest had grown to be a considerable mass fifteen inches across and four to five in height. This, then, was the maximum of the first year's building.

After another year, October 24, 1907, this incipient nest measured 6 by 18 inches. The ground on which it was placed was an artificial ridge falling off to the East as a shallow depression and from now on it became evident that the earth placed by the ants tended to spread unequally and the measurements from the ground level were greater on the east and less on the west. Thus June 12, 1908, the mass of earth was 21 inches from NW-SE, 18 inches wide from NE-SW, while the height was 8 inches from the ground on the west and 12 from the level on the east. More ants were now busy over the mound, but grass blades and small shoots of honeysuckle were growing up in the midst of the nest. In the fall of that year, October 18, the mound measured 9 by 26 inches and was quite conspicuous and

well covered with small sticks and minute pebbles as well as several snail shells, flat and several millimeters in diameter; thus showing that much material had been added to the mound from surface collections, while originally all the material had come from subterranean excavations. At that date, though there had been frosts, the temperature was 70° F. and yet only one or two ants were to be seen on the mound. No more measurements were made till August 7, 1914. It had then become a noticeable mound arising abruptly on the west where bordering an obscure path apparently used by dogs, and sloping gradually on the east down to the lower level. The top of the mound was bald, covered with small sticks and stones, but about the middle height was a tangle of straggling grass stems. The "stones" were such as ants collect; some may be 7 x 5 mm. and weigh 200 milligrams. Many ants were active about the base, but none up on the mound. A similar nest stood some 80 feet to the North. The measurements taken were: height 12 on west; 19.5 on east; diameters 42 east and west, 38.5 north and south.

September 19 of the following year, 1915, it measured 16 on west, 24 on the east, 47 north and south, and 52 east and west. It seemed well cared for with large fragments of stick and stone recently added to the dome to build up after heavy rains and was covered with very active ants. Both base and summit were bare with the sparse grass growing out from the sides of the mound in a zone.

After more than a week of rain in a cold wet season, the nest, June 18, 1916, was still in good form with much fine sand newly applied and swarming with actively working ants. The measurements were: west 16, east 21 in height; north and south 50, east and west 53 in width. Thus the mound had not gained, but apparently lost somewhat of its greatest height since the previous autumn, though its increased diameters suggested winter denudation had spread the material and as yet the loss of height had not been made good.

No measurements followed till the spring of 1919, April 13, when on account of cold few ants were working, though in the immediate neighborhood some dozen fine new nests of this same general age all showed much recent activity by presence of

fresh earth over the domes. Then as in 1916, the incipient nest remained very much steeper on the north slope and still had an irregular band of green grass in tufts from half way up the slopes to near the base. The surface was covered about an inch deep with fine pellets and dried earth apparently brought out this spring to replace denudation and a series of partly open tunnels and pits across the apex of the mound showed that the interior had been exposed by destruction and removal of the roof in that part. The measurements were: west 15, east 24, north-south 58, east-west 54. Later, October 18, the grass around the middle zone had grown tall but the honeysuckle that surrounded the nest stopped abruptly, leaving a bare narrow yard all about the base of the mound, no spray or stem of the honeysuckle reaching over this dead space to the base of the mound. The bald top with bits of stick and gravel extended down farther on the southerly exposure. The measurements were: west 18, east 28, east-west 60, north-south 63. Thus in this single season of building the ant's mound had risen three to four inches and spread out five to six in diameter.

July 25, 1920 the mound swarmed with ants but some other mounds near by were more populous. The bald top of the mound was in sharp contrast to the sides grown up with tall grass amidst which the ants had accumulated heaps of earth pellets that formed a spongy mass with irregular cavities. The grass holds the sides in very steep slopes. The moat-like encircling dead space on the level without the base of the mound was strewn with dead leaves but the honeysuckle stopped short at its outer edge. The mound had grown so that the North-west-South-east diameter much exceeded the shortest diameter. The measurements were then: West 18-20, East 24-30, North-South 57, East-west 54. By the 19th of September the mound had increased somewhat; the height being West 21, East 28, the width North-south 60, East-west 57. Very few ants were to be seen at this time of year and the nest had been got into fine condition for the winter, being covered with fresh roofing of whitish clay pellets as if from deep subsoil, along with many bits of grass stems, one to one and a half inches long, dispersed through with scattered black, dried, excreta of some large caterpillar. At the

end of its fifteenth year the mound was rather imposing, being 16 feet about the base, with abrupt slope on the north 30 inches up the steep to the summit, and 48 from the summit down to the ground to the South, while the west slope was 33 and the east 44 inches from summit to ground level.

August 21, 1921, the mound was in fine condition with newly capped dome, but owing to cool weather and time of day, 6.30 p. m., but few ants were slowly going over the dome and about the neighborhood of the nest. The measurements were: West 21, East 30, North-south 72, and East-west 72. The greatest North-west-South-east diameter was 76 inches. The surface distances over the top were: East-west 82, North-south 85 and greatest North-west, South-east 88. The circumference of base was 18 feet. In general appearance the mound presented a high state of differentiation. The surrounding bare space or moat strewn with dead leaves and twigs of vine that stops in growth at its outer edge, makes more striking the sudden rise of the mound from the level of the ground. The lower parts of the slopes of the mound are covered with talus of loose mouthfuls of earth rolled down from upper levels. Higher up is a faint zone of scattered grass, and still higher up a higher zone of still more sparse grass. The rounded dome is free from grass and covered with fresh light-colored subsoil and bits of dead twigs deposited to form a sort of rudely thatched roof. Near the summit of the north a minute crater seemed possibly still open to the interior. The north face remains much the steepest and the summit is nearer the north and far from the southerly limits of the mound. At this period of great development of the mound a new incipient nest was being constructed 42 inches to the North-west from the adult mound and if this may be regarded as an offspring from the large community, it may indicate its maturity and a successful effort at colonization of the neighborhood.

July 20, 1922, with temperature of 93, after many rains, the mound was swarming with very active ants that also spread many feet from the nest amidst the honeysuckle and grass. The mound presented several open holes of exit near the top but no ants were working near the top. The growth of grass on the sides of the mound was sparse and sickly, the honeysuckle dead

in a broad band of a foot width about the base. The elongation of the mound to the South-east was very evident as well as the great steepness of the north slope. The measurements were: West 23, East 30, North-south 81, East-west 79, as computed from surface measurements of East-west $91\frac{1}{2}$ and North-west, South-east 99. Measured again in the fall, September 10, 1922, it was: West $20\frac{1}{2}$, East 32, width North-south 87, East-west 73. The distance around the base of this seventeen year old mound was 20 ft. 6 in., the distance up the north slope 3 feet and up the long south slope 5 ft. 22 in. The tape over the surface showed a distance of 8 feet 4 in. in the North-south direction and 7 ft. 4 in. East-west. This being a clear warm day ants were abundant upon the mound carrying up and dragging earth pellets toward the summit which was conical and closed, in spite of heavy recent showers. The mound was recently covered with fresh light earth with very many light fluffy cast-off pupa cases lying about as if brought up by ants from within the nest. In some parts of the circumference of the base there was more than a foot in width of dead honeysuckle. Large streams of ants ran to and from a tulip tree about twenty feet distant and many up and down the tree. Fifty feet to the east were evident several new young nests.

In the next year, 1923, measurements were made July 8, when the height had fallen, west 19, east 29, east-west 76, north-south 84 corresponding to surface distances of 89 and 98 inches. Apparently the lessened height might have come from denudation which added to the diameters. The mound was in fine state of preservation, not injured at the top and the ants were bringing out earth through holes near the top. The sparse grass still present about the upper reaches of the mound did not prevent much fine clean earth from rolling down and spreading to the south-east.

The next measurements, January 27, 1924, showed a greater depression of the summit, west 16, east 27, north-west-south-east 86, north-east-south-west 75. For the first time the angles of slope were measured as follows: North 45° , West 45° , East 40° - 38° , longest South-east slope 35° . Other measurements were: circumference 20 ft. 2 in., distance over top North-west-

south-east 98, northeast-south-west 89. An evident cause for the diminished height was the crushed in state of the top of the dome which was flattened and marked as if by human footprints partly filled in by the ant's work. No actual break into the interior remained. A large human footprint on the north-east slope near the top indicated disturbance with the normal surface. The entire mound was frozen stiff, smooth on the surface with some of the small tufts of grass still green about the lower parts of the slopes.

July 20, 1924, after several days clear and dry, in a very rainy season, the ants were very active over the surface of the mound at four to five p. m. Mound in a fine state of repair with four holes near the top on the north and one at the summit nearly, from which ants emerged; other holes concealed by talus except on the base of the north where talus was absent and old holes of egress show plainly, so that the north side seemed inactive and dead in comparison with the very long talus of fresh mouthfuls running far down to the south-east. Grass about eight inches high but not very flourishing made a ring about the bare summit. The moat or bare space about the base of the mound was very conspicuous from dead defoliated honeysuckle and stone or gravel made clean by the ants having removed the earth. Two dead branches projected from south-east part of east side near the base. Measurements as made with the aid of a level and angle, tape and yard-stick were: height, west $19\frac{3}{4}$ inches, east 33 inches, diameter east-west 88 inches, north-south 85 inches, north-west-south-east 96 inches, width of moat: north 12, west 19, south 16, east 14, circumference at base: 22 ft. 6 in., circumference of moat 29 ft. 8 in. Angle of slope: north 35° , but at base 45° where dead and full of holes; south-east 28° , west 35° , east 35° . Distance by tape up west side: 3 ft. 4 in., up north 3 ft. 4 in., up east 4 ft. 4 in., up south-east 5 ft. 11 in.

The final measurements made at the end of the year 1924, December 20, showed the mound as it then appeared at the height of its recovered maximum, after the previous period of depression but they are not added to the following table since

MEASUREMENTS								CALCULATIONS					
Dates	Height	W.	E.	Width	N. S.	E. W.	Circumference in inches	Contents cu. ft.	Increment cu. ft.	Duration months.	Increment per month.	Increment per working month.	Increment per working day in cu. in.
1906-7-7	3			9				.012	.012	7	.001	.006	.345
1906-11-13	4-5			15				.151	.139	4	.034	.046	2.699
1907-10-24	6			18				.291	.013	11	.001	.028	1.636
1908-6-12		8	12		18	21		.564	.273	7	.039	.136	7.733
1908-10-18	9			26				.912	.348	4	.087	.087	5.011
1909-12-31									.518	14	.037	.103	5.922
1910-12-31									.444	12	.037	.088	5.068
1911-12-31									.444	12	.037	.088	5.068
1912-12-31									.444	12	.037	.088	5.068
1913-12-31									.444	12	.037	.088	5.068
1914-8-7		12	19		38	42	3.72	.296	.296	8	.037	.095	5.472
1915-9-19		16	24		47	52	7.35	3.63	3.63	13	.279	.726	41.817
1916-6-18		16	21		50	53	7.359	.009	.009	9	.001	.004	.230
1917-12-31								.874	.874	18	.048	.006	.345
1918-12-31								.586	.586	12	.048	.009	.518
1919-4-13		15	24		58	54	9.012	.193	.193	4	.048	.193	11.116
1919-10-18		18	28		63	60	13.048	4.036	4.036	6	.672	.800	46.08
1920-7-25		18 20	24 30		57	54	10.029	-3.019	-3.019	9	-.35	-.115	-6.624
1920-9-19		21	28		60	57	192	12.009	1.980	2	.990	.990	57.024
1921-8-21		21	30		76	72	216	20.945	8.936	11	.812	1.789	102.846
1922-7-20		23	30		81	79		25.44	4.495	11	.408	1.124	64.742
1922-9-10		20½	32		87	73	246	25.44	0.000	2	.000	0.000	00.000
1923-7-8		19	29		84	76		23.04	-2.40	10	-.240	-.800	-46.08
1924-1-27		16	27		86	75	242	20.988	-2.042	6	-.340	-1.021	-58.809
1924-7-20		19¾	33		85	88	270	29.813	8.825	6	1.470	2.941	169.401
					(96)								

they so closely agree with those of July, some slight falling off being due to a defect near the north summit caused by human feet. This table shows all the measurements taken in the years 1906-1924 inclusive, as well as some calculations of bulk reckoned on the assumption that the mound may be a conical figure. Graphs have been made to illustrate the main facts of the table. They show that the growth in height and in diameter taken from the measurements of the last part of each year, rises steadily for a few years as two nearly parallel curves and then the height curve becomes more flat and with indented summit while the width curve continues to a much greater height and with no

flattening, yet with depressions and recoveries. In a drawing showing the projections of the circumference of the mound as measured or calculated each year the circles enlarge concentrically and rather uniformly at first and then, in this special case of the mound being erected upon unlevel base, the north-west-south-east diameter elongates and the outlines become more elliptical with the axis shifted to west of north.

The curve of the bulk, as plotted from the calculated bulks at ends of years, shows steady rise for the first years; a depression in 1920 followed by greatly increased acceleration with a second set back in 1923 followed by a sharp rise above all previous heights. All these plotted results show irregularities which suggest complex factors acting upon the growth of the mound. The very slow growth the first years is striking as well as the very rapid growth in some later years correlated with the small numbers of ants in the incipient colony at first and the immense numbers in the old successful community. The ants work but half of the year at most, lying dormant in November to March inclusive.

It is to be emphasized that the growth is very irregular, the only constant numbers in the table are the interpolated figures in the seven years when measurements were not actually made. While some of these irregularities are due to crude measurements many seem to be the results of complex factors and they actually may express the resultant of causes of success or failure in the community. Thus in the years of no progress and of actual diminution, the loss of height is sometimes compensated by increase in width since the materials are spread out laterally in place of being accumulated at the apex; but there is sometimes an actual diminution in bulk. As the interior of the mound is spongy and readily compressed by large animals walking on the mound it sometimes happens that the measured bulk may diminish when the mass is the same or greater. Possibly some storms may actually carry material in some quantities away from the nest so far that it is not soon returned by the ants and thus the mound may be washed away if the ants are not very successful some seasons in combatting this constant denudation. When a mound is deserted it slowly dwindles

through some years but eventually is all washed away. This particular colony of ants had a very difficult soil to deal with and the progress made at first was much behind that reported by McCook in a region of sandy wood soil. Like all loosely piled earth, the nest must suffer shrinking and condensation from settling when this is not actively counteracted by ant work.

During the years that this mound had been forming others were made in the same soil nearby and these had grown to about the same dimensions. Two little mounds were started near the above mound and may well have been colonial offspring from it. As far as measured they have the same very slow rate of starting and are in the same soil. The following table shows these young mounds starting on their long period of trial, at the same cautious pace:

	Nest No. 2	Width	Contents cu. ft.	Material
1921-8-26	4-5	8-10	.054	Subsoil, clay
1922-7-22	3	11	.054	Subsoil, clay
1922-9-10	3	11 x 14	.070	Earth
1923-7-8	4	14 x 14	.117	Earth and sticks
1924-1-27	3	15 x 15	.101	Earth and sticks
1924-7-20	4-5	29 x 17	.421	Subsoil
1924-12-20	5-5	18 x 18	.267	Coarse particles and sticks
	Nest No. 3			
1921-9-9	2	13 x 7	.030	Subsoil, Sandy
1922				
1923-7-8	2	11 x 5	.019	Subsoil, sandy
1924-7-20	6.5	19 x 16	.045	Clay, subsoil, sticks
1924-12-20	6	20 x 18	.328	Very coarse particles and sticks

The rate of growth under the natural conditions prevailing is but slow, yet when injury is done to the mound the repair work and reconstruction results in very rapid new formation. Thus the little mound No. 2 was cut into two with a saw when frozen, January 27, 1924, and the half carried away, yet by the following July the ants had made good the loss and added to the former height, width and bulk as shown in the table. In the same way a full grown or adult mound cut into two when frozen

at the same date and one-half removed for study, was found in July completely regenerated and perfect. The ants can thus accomplish much more work in a given time than they would without the stimulus of destructive injury to the mound.

The actual bulk of the mound at the end of nineteen years of work by the ants of this community is about 30 cu. ft., and was thus accumulated at the average rate of about 2 cu. ft. per year. The table shows the actual slow growth of the first years and the rapid growth of some of the later years. The number of ants is unfortunately not known, but they were very few in the first years and very many indeed in the later years. The nascent community accumulated but few cubic inches per day, the mature colony fifty to one hundred or more. As the single ant is but 1-630 part of a cubic inch the labor done is relatively very great and all the work seemed to be done by individuals without aid of fellows. Such facts led McCook to the estimation that considering the bulk and the speed of construction of the ant mound as compared with the bulk and supposed speed of construction of the pyramids of Egypt, the ant may be much more efficient than man, in fact nearly 700 times as powerful a laborer.

In the building of the mound the first two or three years seem to be exclusively years of mining operations, bringing up the earth from the shafts below ground; but after that period the ants begin to construct the mound from two classes of materials. Not only is the excavation process continued and the removed material added to the pile, but there is more and more bringing in of surface material, both surface soil and bits of organic matter such as sticks, straws, leaves and other light particles. In the early stages of mound growth the cast up mouthfuls of subsoil merely accumulate in a loose pile, but the weather compacts them and a denser mass results within which the ants begin to excavate their tunnels above the natural surface of the ground. Thus mound No. 2 had, when four years old, but few internal tunnels merely suggesting the complex labyrinth of the mature mound.

Incidentally it may be noted that in this region no trees seem to be killed by the ants, though that has been described in New England; but the ants keep the Japanese ivy from growing

over the mound and even climb up and kill branches of this vine and of catbriar that may project over the mound though some feet above its surface.

Summary.

In a mound of *Formica exsectoides* measured at intervals during nineteen years the growth was not constant but fluctuating in rate. In the earlier years increase was very slow, in the later years very fast. Interruptions in growth and diminution in proportions may to some extent be referred to external interferences, but probably in part to lack of steady success of the community. Other small incipient mounds start at the same slow rate. Mature mounds require many years for completion to full size.

In the first two or three years the material of the mound is mined from the subsoil, but later more surface soil and collected fragments of vegetable matter are added to the pile.

The rate of growth in reconstruction after injury to, or removal of part of, the mound is much greater than the usual rate of growth. Comparison with other mounds suggests the rate of growth to be strongly an individual character of each community under its own complex environment.

NOTES ON THE GIANT WATER BUGS

(Lethocerus and Benacus—Belostomatidæ Hemiptera)

By H. B. HUNGERFORD,

University of Kansas.

Two papers have appeared recently on *Lethocerus americanus* Leidy. One by W. E. Hoffman¹ and the other by J. R. de la Torre-Bueno.² These remind me of some notes that were taken several years ago and may be of interest. In view of the rather wide popular interest in these huge "electric light bugs" it is strange that no one has given us a monograph of even the American forms. *Benacus griseus* Say and species of *Lethocerus* often attract attention as they fly about street lights and are sent to the entomologist for determination. A good key for the identification of these forms would be most acceptable.

These notes concern the flight of giant water bugs at Lawrence, Kansas, in May 1920, and some notes on the hatching process in one species. We had occasion to use a large number of these bugs in our studies and, therefore, made some effort to collect them. The notes on the collection of insects about the street lights in May 1920 show periods when the Giant Water Bugs were most abundant in flight.

Most of the collecting was done about two street lights. At 8th and Maine Streets 50 *Benacus griseus* Say were taken during the evening of May 5th. The bugs were brought to the laboratory alive in a cloth bag. They made a wheezing noise when disturbed and emitted a decidedly fishy odor. It will be noted below that *Benacus griseus* Say was much more abundant than *Lethocerus americanus* Leidy.

¹W. E. Hoffman, Biological Notes on *Lethocerus americanus*, Psyche XXXI, pp. 175-183, 1924.

²J. R. de la Torre-Bueno, The Last Molt in *Lethocerus americanus* Say Entom. News, Vol. XXXV, p. 369-370, 1924.

Collections of Belostomatidæ at street lights in Lawrence, Kansas, May 1920:

<i>Benacus griseus</i>			<i>Lethocerus americanus</i>	
Date	Male	Female	Male	Female
May 5th	44	57		
May 8th	9	7	1	
May 9th	22	29		
May 21st	9	12	5	
May 22nd	29	16	4	1
Total	113	121	10	1

Some of these bugs were paired and placed in aquaria and numerous egg batches secured. The number of eggs in a mass ranged from 8 to 17 and were placed on supports above the water. In one instance a female laid 17 eggs upon the back of the male. These were attached to the right wing cover near its tip and the male, when discovered, was resting high and dry above the water on the screening of the cage. Most of the egg masses were attacked and sucked dry by the bugs themselves. The eggs when protected from their forebearers have the appearance of those photographed by Dr. J. G. Needham.³ They undergo an astonishing increase in size as they develop. One egg, measured the day it was laid (May 10th), was 4.5 mm. long by 2.25 mm. in diameter. Shortly before it hatched (May 22nd) it measured 6.57 mm. long and 2.87 mm. in diameter. The newly deposited egg has the same color as I have noted for *Lethocerus uhleri* and, if left in the water, does not color up very well. If placed in the air, it becomes longitudinally striped with brown as described by Doctor Needham. The surface is irregularly hexagonally reticulate, the gray and brown being laid down as units. Each hexagonal figure is of a single color, reminding one of the mosaic of a tile floor.

The hatching process is very interesting. I was fortunate

³J. G. Needham, The Eggs of *Benacus* and Their Hatching, Entom. News, Vol. XVII, p. 113, 1907.

enough to be watching an egg through the binocular when the cap at the cephalic end of the egg popped loose and the nymph began its emergence.⁴ The cap was forced up by a bubble confined by a delicate transparent membrane. After the cap was raised by the bubble-like device the head of the bug slowly advanced into the space delimited by the membrane of the bubble which then burst and rumbled up about the opening of the egg shell. This was not the post-natal molt, for when the bug was nearly out of the shell it was still enshrouded by a delicate garment that embraced each limb separately and was shed as the last rite in the hatching process.

Mr. Hoffman, who studied *Lethocerus americanus* Leidy in Minnesota, failed to find the eggs in two seasons' search. On July 20, 1921, at Como Park, St. Paul, Minnesota, I found an egg mass on a dried cattail stalk. The stalk was inclined a few degrees from the perpendicular and on the lower side about six inches above the water surface was found the egg cluster. It consisted of 119 eggs arranged in 6 longitudinal rows and measured 2 inches long and $\frac{1}{2}$ inch wide. The cattail stalk was brought to the laboratory and placed in an aquarium jar. The following morning several eggs had hatched and some were in the process of hatching. At this stage the photograph submitted herewith was made. The nymphs had the groove in the anterior femora which is characteristic of the genus *Lethocerus* and in all probability they belonged to the species *L. americanus* Leidy.

⁴J. H. Fabre, Etudes sur l'instinct et les moeurs des insectes, *Souvenirs Entomologiques*, 18 serie, p. 99, 1903. Gives charming account of emerging of *Reduvius personatus*.



HUNGERFORD: EGGS OF BELOSTOMATIDAE

EXPLANATION OF PLATE II.

Eggs of Belostomatidæ.

- Fig. 1. Dorsal view of male of *Belostoma flumineum* Say bearing eggs.
- Fig. 2. Egg cluster of *Lethocerus americanus* Leidy a little enlarged. Note the hatching bug not yet out of its post-natal molt and the one that has completely emerged. There were 119 eggs in this cluster, arranged roughly in 6 rows. Each egg measured 4.5 mm. long and 2.25 mm. in diameter. The eggs are gray with the free or cephalic end blotched with brown, more especially on the exposed side of the egg which is on the ventral side of the embryo as it emerges. The micropylar area is elongate, light in color and surrounded by a brown band. Pale streaks radiate from this area arranging the irregular brown spots in more or less definite rows. Compare the markings of these eggs with that of the one on the right.
- Fig. 3. Hatching egg of *Benacus griseus* Say: (a) The micropylar area. (b) Indicates the space on the head between the eyes that pulsates sharply and at irregular intervals. Appears to have something to do with the inflation of the bubble which lifts the egg cap. (c) The eye. (d) The thin transparent membrane that confines the bubble. (e) The space not yet filled by the advancing embryo. Soon the bug occupies this space and disrupts the membrane (d) which crumples about the egg shell at (f). Copied by Miss Kathleen Doering from a pencil sketch by the writer.

INSECT FOOD HABIT RATIOS ON QUELPART ISLAND¹

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The following notes represent an attempt to reduce the activities of the insects on Quelpart Island to certain food-habit types and to express the relative importance of these types in terms of parts of the whole, thus establishing a series of ratios. A list of the insects of this island was published recently by Hanjiro Okamoto as Volume 1, No. 2, Bulletin of the Agricultural Experiment Station, Government-General of Chosen, Suigen, Corea, Japan, March, 1924, and the species in this list were arranged and tabulated in accordance with the predominating larval habits of their families.

According to Mr. Okamoto, Quelpart Island is the most southern point in Corea, being the largest island adjacent to that part of the mainland. Its total area is given as about 718 square miles. The highest point is Mt. Kanra with an elevation of 2056 m., and the island consists mainly of tertiary volcanic peaks surrounding Mt. Kanra with a gradual slope to the sea. Mr. Okamoto quotes Dr. Nakai concerning the native plants which number about 1300 species and it is possible to separate the island into seven zones, "of which the southern limit of each is much higher in elevation than the northern, except at the top, where no relation exists with respect to the ocean current, and the seventh zone is consequently level on all sides." The flora of the four lower zones is temperate while a more northern flora is found in the three upper ones. The island therefore has a flora of a wide range. A more detailed description of the area can be found in Mr. Okamoto's paper.

Some 527 species are listed and although this figure does not represent a "complete count," from the information given as to the routes and times of the collecting trips, it does appear as if it might be considered as a representative sample. Even

¹Former papers on the ratios of insect food habits were published in the Ohio Journal of Science, vol. xxiv, pp. 100-106, Entomological News, vol. xxxv, pp. 362-364 and the Proceedings of the Biological Society of Washington, vol. 38, pp. 1-4.

though not strictly representative, it is the nearest approach to it that is available at this time.

In accordance with their family food habits, the 527 species can be grouped approximately as follows:

	No. species	Phyto- phagous	Sapro- phagous	Harpac- to- phagous	Parasitic	Pollen feeders, misc. sp.
Quelpart Island	527	60%	16%	20.8%	1.5%	1.7%

A comparison of the above ratios with the ratios for other sections which have been collected over more thoroughly and which have been treated in a similar way, shows that the parasitic figure for Quelpart Island is too low, due to the fact that the parasitic Hymenoptera are not represented as they should be. From studies of "samples" in other areas, it appears that the parasitic figure should be about 10 and in view of this, 50 species have been provisionally added to the parasitic group making the total number of species 577 and resulting in the adjusted set of ratios found below.

	No. species	Phyto- phagous	Sapro- phagous	Harpac- to- phagous	Parasitic	Pollen feeders, misc. sp.
Quelpart Island	577	55%	15%	19%	10%	1%

It is now possible to compare these ratios with those of other areas and this has been done in the following table I. It will be noted that the figures in each column do not differ widely and suggest a fixed relationship or at least a close resemblance. The same relationships are brought out in a slightly different manner in table II wherein the comparisons are made with the parasitic food habit as a base. For example, if the adjusted parasitic food habit in Quelpart Island is represented by 1, then the relative importance of the other types is, phytophagous 5.5, saprophagous 1.5, etc.

TABLE I

	No. species	Phyto- phagous	Sapro- phagous	Harpac- to- phagous	Parasitic	Pollen feeders, misc. sp.
Quelpart Island	577	55%	15%	19%	10%	1%
Western Arctic Coast of N. A.	400	47%	27%	14%	10%	2%
State of N. J.	10,500	49%	19%	16%	12%	4%
State of Conn.	6,781	52%	19%	16%	10%	3%

TABLE II

Quelpart Island	577	5.5%	1.5%	1.9%	1.0%	0.10%
Western Arctic Coast of N. A.	400	4.7%	2.7%	1.4%	1.0%	0.20%
State of N. J.	10,500	4.1%	1.6%	1.3%	1.0%	0.33%
State of Conn.	6,781	5.2%	1.9%	1.6%	1.0%	0.30%

The adjusted figures for Quelpart Island, with its varied flora, tend to support the suggestion advanced in previous papers, that the ratios between the various types of food habits, based on the species present, vary but little when large areas, each embodying different types of vegetation are considered *in toto* and when the numerical ratios between the species present and the factors tending to reduce or change their numbers are considered as constant.

NOTES AND DESCRIPTIONS OF THE CERCOPIDÆ OF CUBA.

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and

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This is the first of a series of papers on the Homoptera of Cuba which have been collected by the junior author during the past eight years. For some unknown reason the homopterous fauna of Cuba has been neglected since the publication of de la Sagra's "Historia. de Cuba," in 1856, which contained a list of the Homoptera of Cuba by Guérin-Meneville, with descriptions of new species, but he did not include a single Cercopid. In 1864, Uhler, (Proc. Ent. Soc. Philadelphia II: 155-162) described some new species of Hemiptera including three new species of Cercopidæ, *Clastoptera stolidus*, *Clastoptera undulatus*, and *Tomapsis (Monecphora) fraterna*, from Cuba. Again in 1876, (Bul. U. S. Geol. Survey I: 348) he described, *Lepyronia angulifera*, from Florida and stated that he had specimens from Cuba. The present list records fifteen species and one variety; twelve species appear to be new to science, indicating very clearly how much the Cercopid fauna of Cuba has been neglected. One new genus is also described, indicating that Cuba may be an important center for the development of this group. No less than five new species of the genus *Leocomia* Ball are recognized, indicating that Cuba may be an important center for the development of this genus, which was described from Hayti. The genus *Monecphora* is very poorly represented in our collections, only two species, *M. bicincta* Say, and its variety *fraterna* Uhler and *flavifascia* n. sp. *Monecphora bicincta* Say variety *fraterna* Uhler equals *Monecphora fraterna* Uhler.

***Monecphora bicincta fraterna* Uhler.**

Monecphora fraterna Uhler is certainly very close to the common North American *M. bicincta* Say and we believe that the two species are identical. The following points are evident in a comparison of *M. bicincta* from North Carolina, with *M.*

fraterna, from Cuba: Transverse bands on the wings irregular but complete in *bicincta*, usually broken into two or three elongate spots in *fraterna*. Vertex broadly rounded with median carina rather indistinct or not indicated on the pronotum in *bicincta*, vertex rather acutely angled with the median carina distinct, and usually strongly indicated on the pronotum in *fraterna*. Genital styles of the male rather acute at the apex, not strongly recurved, in *bicincta*, rather obtuse and strongly recurved, in *fraterna*.

This common species is a pest of "Parana" (*Panicum numidicum*) in Cuba and occasionally attacks sugar cane. It has been collected in the following localities: Manzanillo, July 31, 1922, S. C. B. and C. H. B.; Nagua, Oriente, July 7, 1922, S. C. B. and C. H. B.; Santiago de las Vegas, Sept. 2, 1915, S. C. B.; Baracoa, April 19, 1916, P. C.; Camaguey, Oct. 10, 1911, P. C.

We also have a single specimen from Manzanillo, July 21, 1922, S. C. B. and C. H. B., which is nearly uniform dull black above with pale golden pile. Transverse band narrowly indicated on the pronotum, dark red; transverse bands on the fore-wings indicated by a series of narrow elongate spots; face and eyes shining black. Legs and venter more or less washed with red; abdomen black with the borders of the segments and lateral pieces narrowly bright red. Otherwise this specimen seems to be identical with *M. bicincta ignipecta* Fitch.

***Monecphora flavifascia* n. sp.**

This species is very close if not identical with the dark form of *Monecphora saccharina* Dist. as illustrated by Williams (Memoir no. 1, Dept. Agr. Trinidad and Tobago.), but this species differs in several essential details from typical *M. saccharina* in our collections from Trinidad. We believe therefore that it should be described as a new species, especially since it may prove to be of economic importance as a sugar cane pest.

Vertex about one half as long as width between the eyes, anterior margin rather pointed; discal area strongly elevated; ocelli separated from each other by about the diameter of a single ocellus; face strongly inflated, transverse ridges con-

spicuous, median carina well elevated. Pronotum nearly twice as broad as long. Spine near base of hind tibia short, weak, spine near apex long stout. Male genitalia with the ventral gonapophyses short and stout, contiguous to their apices which are obliquely truncate; lateral gonapophyses elongate, widely separated basally, contiguous apically, the apices claw-shaped with the two claws inclosing a nearly circular area; oedagus slender, inclosed in an evident sheath basally; tenth and eleventh segments sub equal.

In *saccharina* the ventral gonapophyses are elongate, contiguous to the apical third, then curvingly separated ending in short blunt processes; the lateral gonapophyses are elongate well separated basally then contiguous in the middle of their length and then widely divergent, the claws inclosing a long oval area.

Holotype, male, Perico, Matanzas, September 30, 1910.

Allotype, female, same locality.

Paratypes, 3 males, 12 females, same locality.

Leocomia Ball.

The genus *Leocomia* was described by Ball in 1919 (Proc. Iowa Acad. XXVI: 143-150) from a single specimen from Hayti. We describe below six new species of this interesting genus which seems to be West Indian in its distribution. Our species differ from the generic description as given by Ball in having a prominent spine in the middle of the hind tibiæ, and in other minor points, but we do not think that they are generically distinct. One of these forms was collected from *Pilia* sp. but the food plants of the others are not known.

Leocomia grisea, n. sp.

A uniform grayish species, the largest of the genus from Cuba, with a well produced vertex and strongly sloping wings.

Vertex flat, strongly produced in front of the eyes, gradually narrowed to the apex; ocelli slightly nearer each other than the eyes; eyes moderately large, not prominent; frons flat; pronotum but little longer than the produced vertex; anterior margin broadly rounded, posterior margin shallowly

excavated; mesonotum about twice as long as broad equaling the pronotum. Venation of fore wing weak; venation of hind wing typical. Hind tibiae with two spines both stout, the one at the middle twice as long as the one at the base.

Color above and below, nearly uniform grayish tawny, eyes, median area of the frons, tip of the rostrum, spines, claws and ovipositor, blackish.

Length, 5.10 mm.; width across prothorax, 2.10 mm.

Holotype, female Sierra Maestra, 3000-3500 ft., July 10-20, 1922, S. C. B. and C. H. B.

***Leocomia balloui* n. sp.**

This is another species with a strongly produced vertex, dull black to piceous variegated with creamy white and tawny.

Vertex foliaceous, flat, strongly produced about two-thirds the length of the pronotum; ocelli rather close together; eyes rather prominent; frons very flat; pronotum rather strongly arched; mesonotum about as long as vertex, apical portion rather slender. Fore wings nearly vertical, strongly roughened, venation prominent; venation of hind wing typical. Middle spine of hind leg large, basal spine small.

General color dull blackish or piceous; anterior margin of vertex, tawny; fore wings with a narrow creamy white band extending irregularly from the claval margin near the middle of the mesonotum to the middle of the costal margin, apical third creamy white to tawny with veins black.

Length, 4.90 mm.; width across prothorax, 1.80 mm.

Holotype male, Pico Turquino, July 20, 1922, S. C. B. and C. H. B., 5000 ft.

Allotype female, Pico Turquino, July 20, 1922, S. C. B. and C. H. B. 5000 ft.

***Leocomia nagua* n. sp.**

A short robust species with short wings and a short vertex.

Vertex rather short parabolic, ocelli equidistant from each other, and the eyes; frons slightly produced, but flat on the disc; pronotum about twice as broad as long broadly curved and

somewhat angled anteriorly, deeply angulate posteriorly; mesonotum nearly as long as pronotum sides slightly arcuated. Fore wings rather broad, short, rounded posteriorly; venation distinct apically. Middle spine of hind tibiæ long, basal spine small.

Color, dull piceous brown with golden yellow pile; fore wings with a diagonal band from the middle of the clavus to the middle of the corium, and two small transparent spots on the costal margin, one near the middle and one near the apex of the wing. Sometimes two large greenish white spots on middle of pronotum.

Length 3.90 mm.; width across prothorax 1.80 mm.

Holotype male, Nagua, Oriente, July 1922, S. C. B. and C. H. B., 850 ft.

Allotype female, Nagua, Oriente, July 1922, S. C. B. and C. H. B. 850 ft.

Paratypes 2 males and 1 female Nagua, Oriente, July 1922, S. C. B. and C. H. B., 850 ft.

***Leocomia maestralis* n. sp.**

This is a dull tawny species with a rather short acute vertex.

Head as wide as the pronotum; vertex produced, narrowed anteriorly, rather acute; ocelli nearer each other than the eyes; frons flat; pronotum nearly twice as broad as long, not much curved anteriorly, excavated as a right angle posteriorly; mesonotum as long as the median length of the pronotum, sides lightly arcuated. Fore wings elongate, somewhat expanded on the costal margin, somewhat rugose, veins narrow but rather distinct; spines on the hind tibiæ stout.

Color, dull tawny clothed with golden pile; face and abdomen brown; apex of fore wings shading to brown; eyes dull black, claws and spines black.

Length 4.50 mm.; width across prothorax 1.60 mm.

Holotype male Sierra Maestra, July 10-20, 1922, S. C. B. and C. H. B., 3500-4200 ft.

Paratype male, Sierra Maestra, July 10-20, 1922, S. C. B. and C. H. B., 3500-4200 ft.

Leocomia pileae, n. sp.

A medium large species for the genus, dull black, with very short vertex.

Head slightly narrower than the pronotum, vertex short, rather acute anteriorly; frons strongly produced, the disc flattened, the lateral margins slightly inflated, faintly transversely striated; pronotum nearly twice as broad as long, sloping anteriorly; mesonotum elongate, the lateral margins strongly sinuated, the apex rather acute. Fore wings strongly sloping, rather rugose. Legs short and slender, the middle spine of the hind tibia elongate, stout.

Color black, anterior margin of vertex broadly dull yellow, sometimes entire vertex and anterior margins of prothorax dull yellow.

Length 4.90 mm.; width across prothorax 1.70 mm.

Holotype male Pico Turquino, July 20, 1922, S. C. B. and C. H. B., 5500 ft.

Allotype female Pico Turquino, July 20, 1922, S. C. B. and C. H. B., 5500 ft.

Paratypes 1 female and 2 males Pico Turquino, July 20, 1922, S. C. B. and C. H. B., 5500 ft.

Leocomia fulva, n. sp.

This species may be recognized by its large size, pale golden yellow color and triangularly produced vertex.

Head rather narrow, pointed, the anterior margin nearly a right angle with the margins nearly straight lines; pronotum elongate, its length nearly two-thirds the width, the lateral margins strongly contracted and the posterior margin deeply indented by the mesonotum, with a distinct percurrent median carina; mesonotum broad, the lateral margins strongly sinuate, tip narrow.

General color golden yellow, the eyes and the tips of the fore wings shading to deep brown; legs and beneath, golden brown, the spines and tips of the tarsi and claws black.

Length 5.2 mm.; width across prothorax 2.1 mm.

Holotype female Pico Turquino, Cuba. July 20, 1922, 5000 ft. S. C. B. and C. H. B.

***Enocomia maestralis*, n. sp.**

This species is placed in the genus *Enocomia* Ball with great hesitancy as it does not agree in all points with the description of that genus.

Vertex narrow, transverse, somewhat rounded anteriorly, its median length greater than the length next the eyes; ocelli closer to each other than to the eyes; frons inflated, the median area with a prominent circular impression; pronotum broad nearly twice as broad as median length, lateral margins strongly converging posteriorly; mesonotum shorter than the pronotum. Wings short, broad, strongly inflated without an appendix, venation fairly distinct. Posterior tibia with a short stout spine beyond the middle, a very small spine at base.

General color, blackish brown shading to lighter on the apex of the vertex and the apex of the wings, with conspicuous pale yellow c-shaped marks on either wing. Vertex brownish, shading to pale yellow anteriorly; face black, dorsally pale yellow with four short dark arcs broken on the median line; eyes dark gray; pro- and mesonotum brownish uniformly covered with pale yellow pile. Fore wings blackish brown shading to paler apically, where the veins are blackish and conspicuous, uniformly coarsely punctured and covered with pale yellow pile. Base of the clavus with a broad pale yellow stripe which curves across the claval suture, then anteriorly to the costal margin, this stripe is more or less broken on the middle of the corium; apex of the clavus pale yellow, tibiæ and tarsi pale brownish yellow with the claws and tips of the spines black. Abdomen dull black.

Length 3.9 mm.; width across the prothorax 1.9 mm.

Holotype male Sierra Maestra 10-20 July. 1922, C. H. B. and S. C. B., 3250-4400 ft.

Allotype female, Pico Turquino, 20, July 1922, S. C. B. and C. H. B. 5000 ft.

Paratype 1 male and 1 female Pico Turquino, 20 July, 1922, S. C. B. and C. H. B. 5000 ft.

Dasyoptera, gen. n.

In general appearance the members of this genus suggest a small species of *Aphrophora* Germ. and the venation of the fore and hind wings is quite similar. They differ however, in many important points.

Head narrower than the prothorax, somewhat angulate anteriorly; anterior disc of the vertex horizontal, posterior disc sloping; face elongate, flat, the disc flat giving the appearance of an elongate oval impression; pronotum broad nearly twice as broad as long, and the anterior margin distinctly broadly angulate, the lateral margins distinctly produced into shoulders; mesonotum nearly as long as the pronotum, broad anteriorly with the lateral margins concave, the apex attenuate. Fore wings long and narrow, the venation strongly elevated giving a very rugose appearance; venation about as in *Aphrophora* Germ., hind wings long and narrow, venation as in *Aphrophora*. Legs short, hind tibia with a long stout spine beyond the middle, and very short obtuse spine near the base.

Type: *D. variegata*, n. sp.

***Dasyoptera variegata*, n. sp.**

This species may be recognized by its general golden brown color, with the vertex and pronotum strongly marked with black.

Vertex broad, short, somewhat angularly produced anteriorly about half again as long on the median line as next the eye; face nearly twice as long as broad, faintly ovally impressed on the median line; pronotum viewed laterally broadly arched.

General color golden brown with golden yellow pile, this pile much paler in definite areas giving a spotted appearance; face with two large black spots apically, these spots continued over the apical margin as two black dashes on the vertex; posterior margin of vertex with two large black spots which are twice as far from each other as from the eyes; pronotum with a row of six small black spots near the anterior margin. Fore wings

with many spots of pale pile; hind wings transparent with brown veins. Legs and beneath, golden brown, the hind tibia darker.

Length 6 mm.

Holotype female Pico Turquino, Cuba, July 22, 1922, S. and C. H. B., 6770 ft.

Lepyronia robusta n. sp.

A short robust species similar to *Lepyronia gibbosa* Ball but shorter, more robust and darker.

Vertex about half as long as its basal width; tylus triangular, deeply impressed; ocelli twice as far from each other as from the eyes; face moderately convex. Pronotum twice as broad as its median length, broadly incised posteriorly. Mesonotum lozenge-shaped. Fore wings short, broad, inflated; venation fairly distinct, typical; hind tibia robust, with two lateral spines about equidistant from each other and the base and apex of the tibia, the apical spine stouter. Male genital plates inflated, about three times as long as broad, together elongate oval.

Ashy gray above, darker on the vertex, pro- and mesonotum and clavus; the fore wings with a diagonal dark band from apex of clavus to middle of costal margin, and another band at apex of wings; the whole upper surface densely covered with short golden pile. Whole ventral surface, including eyes, legs and abdomen blackish.

Length male, 4.3 mm., length female, 5.6 mm.

This is apparently a very variable species and we are by no means sure that the two specimens listed under this name really belong together, but until more specimens are at hand, they may as well be listed thus.

Holotype male, Santiago de las Vegas, Jan. 9, 1922, S. C. B.

Allotype female, Manzanillo, July 31, 1922, S. C. B. and C. H. B.

Clastoptera undulata Uhler.

This species may be recognized by its pale face with a broad brown band below the middle, and a series of seven to nine interrupted arcs above; vertex pale, crossed by an irregular brown band; pronotum pale with two brown arcs across the

middle, interrupted on the median line, and the posterior third clouded with brown; mesonotum dark, lateral margins pale. Fore wings dark with an irregular pale band across the middle, and the apex transparent.

We have a single typical specimen from Taco Taco, April 1-6, 1922, C. H. B. and S. C. B. and two paler females, one from Taco Taco and the other labeled Santiago de las Vegas.

***Clastoptera stolida* Uhler.**

This is a dark species with a series of three pale greenish yellow spots across the middle of the wings; vertex and pronotum more or less bordered with pale tawny yellow; face about as in *C. undulata* Uhler; legs pale.

Three specimens from Manzanillo, July 31, 1922, C. H. B. and S. C. B.

***Clastoptera flavidorsa*, n. sp.**

This species may be recognized by its broad short form, and distinctive yellow and black coloration.

Vertex rather short with the vertical part of the frons nearly parallel margined; frons strongly inflated; pronotum about twice as broad as long, broadly curved anteriorly; mesonotum large. Wings short and broad. Legs short and stout.

Head entirely shining black; anterior margin of pronotum bordered with shining black, this border wider on the median line and then narrowed until nearly concealed by the eyes laterad, rest of the pronotum and anterior half of the mesonotum bright yellow; apex of the mesonotum black. Wings nearly uniform brown, apical cell black. Face, venter and legs black, the tarsi shading to brown.

Length 2.75 mm.; width across the prothorax 1.50 mm.

Holotype female, Sierra Maestra, July 10-20, 1922, C. H. B. and S. C. B., 3500-4200 ft.

***Clastoptera cuba*, n. sp.**

This species is nearly uniform brown above, with the face twice banded with black.

Short robust; vertex rather deeply excavated posteriorly together with the vertical part of the frons obtusely rounded anteriorly; frons moderately flat, not inflated; pronotum not twice as wide as long; mesonotum elongate, very acute posteriorly, side margins feebly arcuated. Wings broad, short and somewhat inflated.

General color above tawny brown, corium shading to darker; face crossed by two black bands the area between, pale yellow, dorsal area uniform brown with dark arcs faintly indicated. Legs dull black, knees paler, and the hind tibia ringed with paler near the apex.

Length 2.75 mm.; width across the prothorax 1.74 mm.

Holotype female Palma Mocha Mt., Sierra Maestra 10-20 July 1922, C. H. B. and S. C. B., 3250-4200 ft.

PECTINATE ANTENNÆ IN THE GEOMETRIDÆ
(LEPIDOPTERA).BY WM. T. M. FORBES,
Cornell University, Ithaca, N. Y.

The present note is the summary of an analysis of antennal characters in the Ennomid Geometridæ, for which there seems to be no present hope of publication.

The Geometridæ and especially the Ennomid (Boarmine) series, have always been notorious for the plasticity of their characters and the difficulty of their classification. The present study of antennal characters has developed out of Bodine's work (*Trans. Am. Ent. Soc.* 23, 1, 1896) on the Lepidopterous antenna, and has, I believe brought some significant and useful characters to light.

This discussion includes only the genera with pectinate male antennæ. In the Geometridæ the simple antenna is not primitive, but has been several times produced by reduction. For the present it is not possible to place all these genera, but pupal and other characters will throw light on their relationships.

Bodine recognizes five types of antennal organs: three lengths of setæ, cones, and pit-organs. In the Ennomids the pit-organs seem of little use in classification, and the two types of generally distributed setæ (his types 1 and 3) are not easily distinguished; the presence and arrangement of the long single setæ which he calls type 2, and the thin-walled sensory cones—type 5,—give good characters.

The following grouping may be made:

SERIES I: PECTINATIONS NAKED; CONES ON SHAFT.

There are three subdivisions of this type, corresponding to two natural groups, and a somewhat heterogeneous remainder.

1. Pectinations each with a single distinct seta of type 2, not obscured by long setæ of type 3; pupa with two strong spines on the cremaster, with dorsal groove (between abdominal segments 9 and 10) well developed; moth slender, wing normally with fovea. Antenna usually with a long simple apex.

Protoboarmia (indicataria), *Parexcelsa (inconspicuaris)*, *Eufidonia*, *Nealcis (californiaria)*, *Melanolophia*, *Vinemina (opacaria)*, *Paraphia*, *Epimecis*, *Elphos*, *Boarmia*, (e. g. *rhomboidaria*), *Amraica*. In *Amraica* the antenna is unipectinate, with a superficial likeness to *Arichanna*. The others form a homogeneous group.

2. Pectinations very short, gradually running out to base and apex, slender, central on segments, not clubbed, with long sparse bristles, the apical one not distinct; segments lightly chitinated, with fine striations, transverse on outer part of segments, as in *Melanolophia*.

Bapta (?) virginalis. The remaining *Baptas* have simple antennæ, and resemble *Cabera* (*Deileina*). This species has no likeness to *Cabera* and has no visible connection with any other.

3. Pectinations more or less clubbed, with a terminal tuft of long curved setæ, burying the single short apical or sub-apical seta of type 2. Body stout, mouth parts normally reduced; sculpture normally not unlike group 1, which also has a similar pupa.

Biston (ursaria), *Amphidasys (cognataria, robusta)*, *Erannis* (segments sometimes 4-pectinate, sometimes merely serrate), *Artiora (Therapis)*, *Coniodes*, *Cochisea*. This is a homogeneous group. *Artiora* has usually been widely separated from *Erannis* but hardly differs save in wing-form.

4. Pectinations with at least two strong setæ of type 2, which are typically apical and strongly divergent; and are frequently supplemented by one or more such setæ on the outer sides of the pectinations. A miscellaneous group, held together mainly by the survival of a primitive condition.

A. THREE NEARLY APICAL SETAE OF TYPE 2.

Prosoplopha.

B. A DORSAL SETA (OR MORE) ON PECTINATIONS.

Euchlæna (including *irraria*), *Lytrosis*, *Stenotrachelys*, *Angerona (prunaria, æxaria)*, *Xanthotype*, *Metarrhantis*, *Cepphis (Priocycla)*.

C. ONLY TWO SETAE OF TYPE 2.

Gonodontis (*bidentata*, *formosa*, *ocellaria*), *Abbotana*, *Himera*, *Campæa* (*Metrocampa*), *Ellopiæ* (not *Therina*), *Selenia*, *Hygrochroa*, *Stenaspilates*, *Hypoplectis*, *Scodiona*, *Hulstina*, *Amblychia* (*angeronaria*), *Xandrames* (*dholiaria*), *Arichanna* (transitional to *Melanolophia* group), *Sarcinodes* (unipectinate), *Achlora* (4-pectinate).

SERIES II: PECTINATIONS NAKED, CONES AT THEIR APEX.

This series like the first is composed of three main groups, of which two are more like each other than to the third, and has some anomalous genera of uncertain position. *Nacophora* makes a group by itself, much like the *Biston* group, but differing in egg-type as well as antenna.

1. Basal segment of antennal shaft with well-marked pectinations; posterior series of longer pectinations than anterior, especially toward apex; cones very few, sometimes irregular in position and deformed. Apical setæ of pectinations strong, strictly apical, and not obscured by setæ of type 3; sub-apical seta strong, often arising well back from apex. Pectinations stout and long, tapering, with tips turned distad; strongly chitinized, especially at base, and longitudinally striate; shaft smooth or slightly granular.

Nacophora (including "*Amphidasys*" *arnobia*), *Phæoura*.

2. Cones numerous, normally on both series of pectinations; apical setæ usually two, and well-marked. Tropical species frequently very heavily chitinized. American genera.

Therina (including *quercivoraria* and *læta*), *Nepytia*, *Zerene*, *Sicya*, *Philtræa*, *Philedia*, *Nipteria* (in part), *Lissochaeres* (*nigrovenata*), *Deutophlebia* (*radiata*), *Emplocia* (*bupaloides*), *Leucula* (*cillenaria*), *Carpella* (*districta*), *Sangalopsis* (*beata*),—also "*Diop-tis*" *hesperioides*, for which I have not happened to see a valid generic name,—*Metanema* (*inatomaria* and *determinata*, transitional to group IIc).

3. Cones numerous on one series of pectinations, normally the posterior, usually absent on the other series, but present

on both series on Bupalus, Crocallis and Euctenurapteryx. Old-world genera.

Chemerina, *Cleogene*, *Dasydia*, *Epione*, *Bupalus*, *Euctenurapteryx* (*maculicaudaria*), *Crocallis*. The last genus on most characters is an outlier of series I.

SERIES III. PECTINATIONS SCALED, CONES APICAL.

This is far the smallest, and in antennal structure the most homogeneous of the four series, but the genitalic structure as well as the appearance seems to indicate it is not homogeneous. Gnophos is particularly troublesome, as with a great variety of antennal type the genitalia are homogeneous, while Platæa, which has practically the antenna of *G. dilucidaria*, has wholly different genitalia.

Bases of pectinations conspicuously transversely rugose, and often swollen.

Pectinations basal on segments.

Over 40 segments. *Gnophos*, *Patæa*, *Pherne*

Under 40 segments. *Glaucina*, *Cænocharis*

Pectinations subapical.

Segments under 40, pectinations short. *Carphoides*, *Barnesia*

Segments over 40, pectinations long. *Pterotæa*

Bases of pectinations smooth or nearly so.

Antenna pectinate to apex.

Lightly chitinized; segments stout. *Ennomos*

Heavily chitinized; segments very slender. *Aspilates*

Antenna with a long simple apex. . . (a few aberrant *Nipterias*)

SERIES IV: PECTINATIONS SCALED, CONES BASAL.

There are two main types involved in this group, one represented by Cabera and Apicia (*Caberodes*), in which the cremaster of the pupa has eight hooks, and the other by the Cleora group with a bifid cremaster. There is a corresponding difference in the appearance of the moth and of the antennæ, and the groups are no doubt natural, although at present impossible to define. *Ametris*, commonly put with the *Ænochrominæ*, seems to belong

here, while the true *Cenochromids* fall in series I; *Cleora* and *Ripula* have doubly pectinate antennæ, the pectinations alternately scaled and naked. *Cleora* may be ancestral both to the *Cleora* group of this series and the *Melanolophia* group of the first, the inner pectinations having disappeared in one case and the outer in the other. *Ripula* has no obvious affinities. The diurnal forms *Epelis* and *Ematurga* seem to be separately derived from something near *Itame*, and should not be combined in a single genus, as has been commonly done, following *Hulst* in *Dyar's* list. The following grouping is largely artificial and for the convenient tabulating of some characters only.

Synopsis of groups.

Pectinations basal

Sculpture strong on pectinations, setæ of type 2 apical, not strong. Group *A*

Sculpture weak on pectinations; setæ subapical and obsolescent, lost among the setæ of type 3. Group *B*

Pectinations central or apical

Strongest seta of type 2 subapical, short and weak as a rule, when near the apex lost among a mass of longer setæ of type 3.

Subapical seta strong, comparable with the apical. Group *C*

Subapical seta less than half as long as the apical and weak, but distinct. Group *D*

Subapical seta not recognizable, lost in the setæ of type 3 or (more probably) absent. Group *E*

Pectinations ending in a strong and conspicuous apical seta
No subapical or dorsal seta, only the apical type-2 seta present. Group *F*

Subapical seta well-marked, no dorsal seta

Pectinations apical. Group *G*

Pectinations central. Group *H*

Subapical seta strong; a few, at least, of anterior pectinations with a third dorsal seta at about a third their length. Group *I*

Pectinations with apical seta more or less distinct, but not fully apical, at least on some segments; subapical strong; sculpture of shaft weaker than in group D

Group J

A: *Selidosema* (*ericetaria*, *ambustaria* but not the American species sometimes included).

B: *Lychnosea* (*helviolaria* only), L. (? "*Hyperitis*") *trianguliferaria*, *Stegania* (*trimaculata*), *Ripula*.

C: *Caripeta*, *Hemerophila* (*abruptaria*). A wholly artificial pairing, I suspect. *Caripeta* has a pupa similar to *Cabera* and *Apicia*, *Hemerophila* is much more suggestive in all ways of *Lytrosis* in series I.

D: *Vitrinella* (*pampinaria*).

E: *Itame* (*Diastichtis*, *Cymatophora*), *Physostegania*, *Elpiste*, *Macaria* (species with more or less pectinate antennæ), *Mericisca*, *Buzura* (*suppressaria*), *Eubolia*, *Enconista*, *Epelis*, *Exelis*, *Eumacaria*, *Parapheromia* (*lichenaria*), *Tracheops*, *Merisme* (*spododea*), *Fidonia* (*limbaria*), *Euaspilates*, The South American "*Alcis*" *salmonearia*, and "*Ectropis*" *anaisaria* also belong to this group, but not the genera in which they now stand.

F: *Glena* (*insaria*, *quinquelinearia*), *Anacamptodes*, *Ematurga* (*faxonii*, *atomaria*), *Hyposidra* (*talara*), *Gynopteryx* (*seriaria*), *Hymenomima* (*tharpa*), *Ametris*.

G: *Pseudoboarmia* (*umbrosaria*, *punctinalis*), *Stenoporpia* (*polygrammaria*), *Tornos*, *Hesperumia*, *Chloraspilates*, *Sommatolophia*, *Halesa* (*ænitusalis*), *Erebomorpha*, *Aplogompha* (*riofio*), *Molybdogompha* (*biseriata*), "*Lychnosea*" *intermicata*, *Neoterpes*, *Epiplatymetra*.

H: *Ixala*, *Pterospoda*, *Enemera*.

I: *Cabera*, *Drepanulatrix*, *Catopyrrha*, *Apicia* (*Caberoles*, without *C. irraria*).

J: *Plagodis*, *Anagoga*, *Hyperitis*. This is a homogeneous group on venation as well as antenna.

In the following genera I have been unable to find any trace of cones, or at most a few on the simple terminal segments, so that it is impossible to group them unambiguously. I divide them into artificial groups to call attention to some of their characters.

GROUP I: PECTINATIONS NAKED, BASAL ON SEGMENTS, APICAL
SETAE NORMALLY DISTINCT

Heliothea, *Egea* (no terminal setæ), *Nychiodes*, *Eurrhanthis*,

GROUP II: PECTINATIONS NAKED, APICAL, NO SETAE OF TYPE 2.

Acalia, *Brephos*

GROUP III: PECTINATIONS SCALED.

Nepterotæa (compare *Cænocharis* and *Gnophos*), *Eucaterva*
(compare IV B or IV G) *Narraga* (compare *Epelis*), *Fernaldella*
(very near *Narraga*), *Melanchroia* (Compare IV F).

STERRHINÆ and HYDRIOMENINÆ

Pectinations slender, basal, naked with stiff, sparse and rather evenly distributed setæ, and a minute apical seta of type 2 or none. Cones rare on the pectinate segments; on the shaft in *Xanthorhoe ferrugata*, rudimentary on apices of pectinations in the *Sterrhinæ*.

HEMITHEINÆ

Pectinations naked, with cones usually on the simple apical segments only, but sometimes also on the apices of some pectinations.

NOTE ON PANURGIDÆ (BEES)

BY CHARLES ROBERTSON.

Carlinville, Illinois.

That the cubital cells in *Perditinæ* are the first and third, as stated in my Synopsis of Panurgidæ, Psyche, vol. 29, p. 195, was pointed out by Cockerell (Proc. Acad. Sci. Phil. Jan. 1896, p. 30) who says that on one side of the type ♀ of *obscurata* a petiolate second cell shows. A male taken by me at Orlando, Florida, shows this second cell in both wings. In a recent paper I notice that the third cell is called "second." The relative size of the two cells would be different, when the two veins coalesce, from what it would be if one were obliterated.

On page 161 of my paper it is stated that *Zaperdita maura* is an oligolege of *Physalis*. In the Canadian Entomologist vol. 35, p. 334, Crawford says that Graenicher regards it as an oligotropic visitor of *Physalis*. Graenicher used the term oligotropic in the sense in which I have used it, but that term is used in so many senses that I have adopted oligolege, or oligolectic bee, as more precise.

ANOTHER INSTANCE OF THE NORTHWARD MIGRATION OF ODONATA
IN THE SPRING.

Mr. John B. Paine has informed me that on either May 25th., or 26th., 1923 as he crossed the street from a store to the Custom House in Boston, he noticed on the side walk over a dozen dead dragon-flies. He attached no particular interest to their presence but noted that they were of medium size and dark colored. In questioning Mr. Paine about the matter he told me that the area he crossed was very limited and therefore the large number of the insects and their presence on a city side-walk attracted his notice. Evidently, I believe, they were casualties from a migrating horde such as has been described by Bradford Torrey as seen twice in the city of Boston on a spring northward migration.

R. HEBER HOWE, JR.

The David Mason Little Memorial
Museum of Natural History.

THE NORTH AMERICAN VARIETIES OF *VOLUCELLA* *BOMBYLANS* LINN.

BY CHARLES W. JOHNSON.

Boston Society of Natural History.

My paper entitled, "The *Volucella bombylans* Group in America" (Psyche, 1916, vol. 23, p. 159-163), was written primarily to encourage a study of this group and of their relation to the various species of *Bombus* or *Bremus*. My system of naming in the above paper might deserve some criticism from a strictly nomenclatorial standpoint. I have therefore in the following table and notes endeavored to correct an error and to make more clear my views on the relationship of these various forms.

Volucella facialis Will. cannot be satisfactorily separated from the var. *plumata* of Europe, but as the typical *bombylans* is absent in America, it seems best to recognize *facialis* as a subspecies. I am also considering the eastern *evecta* and the Labrador *arctica* as subspecies, and the other forms as varieties of these subspecies.

The question naturally arises, are these variations worthy of distinct names, especially when European authors have placed twenty-four names (including the American *evecta*, *sanguinea* and *facialis*) in the synonymy under *bombylans*? Ignoring variation, when it exists in such a widely distributed species, does little to encourage a study of this most interesting syrphid. If certain forms do actually resemble the species of *Bombus* in whose nests it is commensal, then a knowledge of the possible limits and distribution of these variations is essential for a biological study,

Table of subspecies and varieties.

- | | | |
|----|---|---|
| 1. | Face yellow, with yellow pile. | 2 |
| | Face black or dark brown, with yellow pile. | 3 |
| 2. | Dorsum of the thorax and the pleura black pilose, third abdominal segment black pilose (Calif. to Alaska).. . . . | |
| | subsp. <i>facialis</i> Will. | |

Dorsum of thorax black pilose, pleura yellow pilose, third abdominal segment black pilose (N. H. to Newfoundland:..

var. *lateralis* Johns.

Dorsum of thorax black pilose, pleura yellow pilose, posterior margin of the second and a large dorsal spot on the third abdominal segment red, bearing reddish pile (Col., Utah, N. M.). var. *rufomaculata* Jones.

3. Antennæ dark brown, thorax with the pile in front of a line between the base of the wings black in the ♂ and mixed with yellow in the ♀, abdomen entirely yellow pilose (Labrador). subsp. *arctica* Johns.

Antennæ red, pile of the thorax and pleura entirely yellow, first and second and the fourth and fifth segments of the abdomen with yellow or red pile (Eastern U. S.).

subsp. *evecta* Walker.

Abdomen with the pile of the first and second segments yellow, the others entirely black. . . . var. *americana* Johns.

Abdomen with pile on the first and second yellow, a portion of the third segment reddish pilose, and the remaining segments with either red or yellow pile.

var. *sanguinea* Will.

***Volucella bombylans* *facialis* var. *lateralis* Johnson.**

V. plumata Macq., Dipt. Exot., 4, Suppl. p. 131, 1844.

V. bombylans form *lateralis* Johns., Psyche, vol. 23, p. 161, 1916.

This is the eastern representative of *facialis* distinguished chiefly by having the pile of the pleura yellow. The variety is quite common at Mt. Desert and the only form I have taken on the island. It belongs to the Canadian zone.

***Volucella bombylans* *facialis* var. *rufomaculata* Jones.**

V. bombylans form *sanguinea* Johnson (*non* Williston), Psyche, vol. 23, p. 162, 1916.

V. rufomaculata Jones, Ann. Ent. Soc. Amer., vol. 10, p. 227, 1917.

This was referred to *sanguinea* in my previous paper, on the strength of the reddish pile on the abdomen. Since then I have

received a specimen from Pennsylvania referable to *evecta* with reddish pile on the third segment, which indicates that Williston probably had eastern specimens before him. *Rufomaculata* seems to be peculiar to the more elevated portions of the Rocky Mountains.

***Volucella bombylans arctica* Johnson.**

V. bombylans from *arctica* Johns., Psyche, vol. 23, p. 163, 1916.

With only the American forms for comparison I would have considered this a distinct species, but it resembles so closely specimens in my collection from the Alai Mountains, Turkestan, received under the name *V. hæmorrhoidalis* Zett., that it seems best to consider it an arctic subspecies of this circumboreal species. Types from Rama and Nain, Labrador.

***Volucella bombylans evecta* Walker.**

V. evecta Walker, Ins. Saund. Dipt., p. 251, 1856.

Walker's description calls for a form with—head black, antennæ reddish, thorax thickly clothed with "tawny hairs," abdomen with black hairs, with two bands of "tawny hairs, one band at base paler than the other which is near the tip." Walker does not clearly define the difference between a light yellow and a reddish yellow so that the pile on the posterior segments of *evecta* may be either yellow or reddish. In actual use the word tawny covers many shades of color from pale ochre to swarthy brown. *Evecta* is the upper austral form extending through the transition zone.

***Volucella bombylans evecta* var. *americana* Johnson.**

V. bombylans form *americana* Johns., Psyche, vol. 23, p. 162, 1916.

This is the more common form, the typical *evecta* being less frequently taken in New England.

***Volucella bombylans evecta* var. *sanguinea* Will.**

V. evecta var. *sanguinea* Will., Synop. N. A. Syrphidæ, p. 186, 1886.

Specimens of *evecta* referable to this variety are rare. A specimen received from Mr. A. B. Champlain, taken at Charter Oak, Pa., July 11, 1917 (H. B. Kirk), has a dorsal patch in the third and the greater portion of the fourth segment with red pile. A specimen from Sherborn, Mass., June 13, 1913 (E. J. Smith), has a large patch of red pile on the third segment while the pile on the fourth and fifth segments is yellow. This variety will have to be restricted to those with red pile on the third segment. It represents—in a way—a parallel variation to that of *rufomaculata* in the subspecies *facialis*, but lacks the red ground color.

INTERNATIONAL ENTOMOLOGICAL CONGRESS.

The *III. International Congress of Entomology* will take place at Zurich from July 19th to 26th, 1925. President: Dr. A. von Schulthess-Schindler.

Informal reception on Sunday evening July 19th; distribution of programmes, etc.

Membership 25 Swiss francs, associates accompanying members \$12.50, Life-membership \$250.00.

Entomological Societies, Institutions and Departments of Zoology, Forestry, Agriculture, Horticulture and Hygiene are invited to send Delegates.

Notifications of papers and exhibits should reach the General Secretary before July 12th. Applications for accomodation in Hotels, etc., should be sent as early as possible. All communications to be addressed to the General Secretary, Dr. Leuzinger, Gloria-Str. 72, Zurich 7, Switzerland.

THE NEW YORK STATE LIST OF INSECTS.

It is expected that the proposed List of the Insects of New York State will soon be issued by the State College of Agriculture of Cornell University, Ithaca, N. Y.

It is estimated that over 15,000 species will be listed as definitely occurring in New York, together with the complete distribution data within the state as known for each species. The lists for several orders are already practically completed. Dr. M. D. Leonard, the editor of the list will greatly appreciate definite New York State records in all groups and will see that full credit is given to every cooperator. All records should be sent to him before June 1, 1925.

Whatever Your Question

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